CHAPTER 10

ROADWAY AND AREA LIGHTING

10-1. General.

Quantity and quality of illumination will conform to the latest issue of the Illumination Engineering Society's (IES) Lighting Handbook, except as modified in this chapter. Data contained in IES RP-8 provides a basic reference relating to the principles of standard roadway lighting practice. Unless otherwise indicated, illuminances are always on the horizontal plane at ground level. Where directed, illuminances will be modified to be in conformance with current energy conservation policies.

10-2. Roadway lighting Design.

a. Illuminances. The average maintained horizontal illumination recommended by IES is based on the type of traffic flow and the character of the surrounding area. On military installations, the values for road and area classification used will range from 4 lux (0.4 footcandles) to 13 lux (1.3 footcandles). Luminaires located along roadways and intersections at spacings ranging from 150 to 200 feet can provide illumination within this range as shown in table 10-1. The definitions of the IES classifications in table 10-1 can be found in the current IES Lighting Handbook. Spacings are approximate and may vary somewhat dependent upon the actual luminaire type, mounting height, roadway width, and other conditions applying. Lux and footcandles are related by an approximate 10-to-1 factor.

b. Luminaires. Luminaires of the enclosed type utilizing high-pressure sodium (HPS) lamps will be used. A discussion of the characteristics of various light sources is presented later in this chapter. Figure 10-1 indicates a typical roadway lighting installation. Bracket length is dependent upon the location of the luminaire and the roadway width, but will not exceed 25 percent of the mounting height. Light distribution characteristics of any luminaire will suit the mounting height, road geometry, and uniformity required. Vertical and lateral light distribution and control of these characteristics will be indicated for each luminaire.

(1) *Vertical.* Vertical light distributions, based on spacing-to-mounting height ratios, are categorized as short, medium, and long distribution. Short distribution is suitable for pole spacings no greater than 4.5 times the mounting height; medium distribution is suitable for pole spacings from 4.5 to 7.5 times the mounting height; and long distribution is suitable for pole spacings from 7.5 to 12 times the mounting height. Medium distribution is the most appropriate choice for the mounting heights and spacings utilized on military installations.

(2) *Lateral.* Lateral (transverse) light distributions, based on the shape of the half candlepower isocandela trace which falls within the longitudinal distribution range, are classified as Types I through V. A general guide to their use, compiled from date in IES RP-8, is shown on figure 10-2. Selection is dependent upon whether the luminaire is situated at the side or at the center of the road, whether the luminaire is located between intersections or at an intersection, and the roadway width. Since most luminaires are mounted at the side of the road, Types II, III, or IV are used more often. Type II is used to light narrow roads, and types III and IV are used for lighting progressively wider roadways.

(3) *Control.* Control of the amount of light in the upper portion of the beam above maximum candlepower is classified as cutoff, semicutoff, or noncutoff. Semicutoff limits the lumen output above the nadir to 5 percent at 90 degrees horizon-

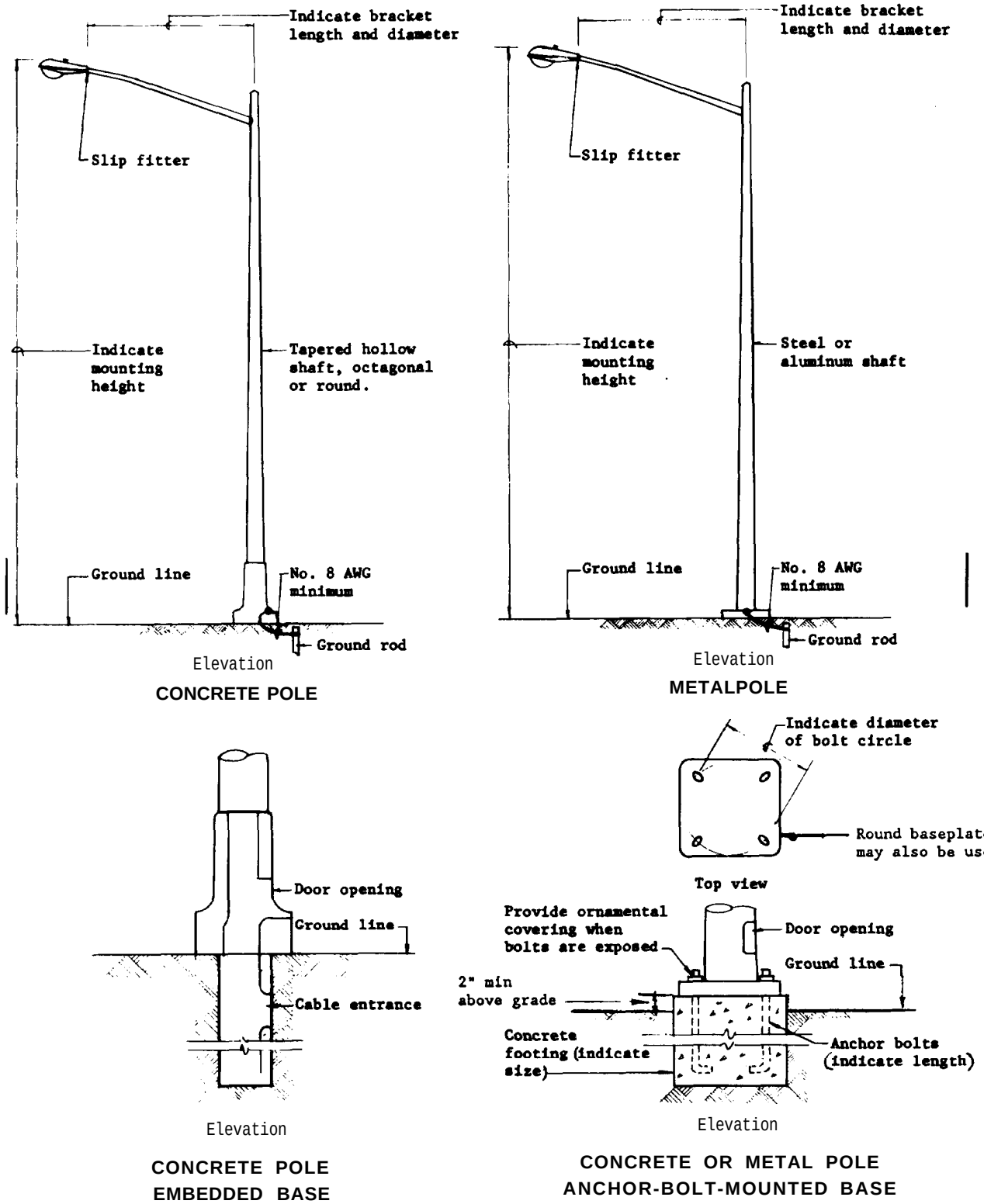
Table 10-1. Illumination Versus Spacing.

lux[a] (footcandles)	Spacing feet[b]	HPS lamp wattage	IES Classification	
			Road[c]	Area
4(0.4)	170	100	Local	Residential
9(0.9)	200	250	Collector	Intermediate
13(1.3)	150	250	Major	Intermediate

[a] Required average maintained illuminance, with a uniformity ratio meeting IES requirements.

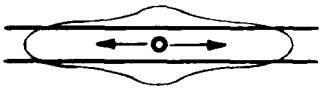
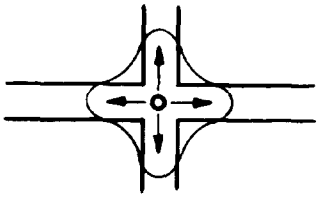
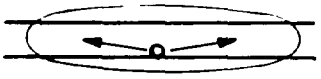
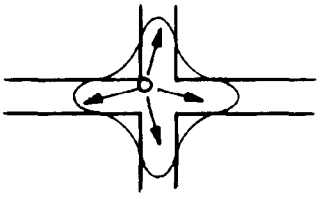
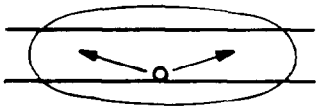
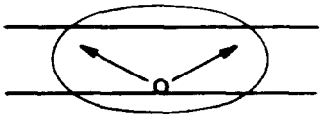
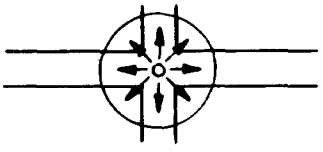
[b] Based on units mounted 30 feet above the roadway on the same side. For intermediate areas, road width is assumed to be 40 feet and for residential areas to be 30 feet.

[c] Based on R3 pavement classification.



US Army Corps of Engineers

Figure 10-1. Typical Roadway Lighting Installation.

Distribution pattern number	Luminaire location with respect to roadway	Distribution pattern shape	Transverse roadway coverage (width) in multiples of mounting height (MH)	
			Tranverse coverage	Placement
I	Center		Up to 2 x MH	Center suspension
I 4-way	Center		Up to 2 x MH	Local roadway intersections
II	Side		Up to 1.0 x MH	One side or staggered
II 4-way	Side		Up to 1.0 x MH	Local roadway intersections
III	Side		Up to 1.75 x MH	One side
			1.75 x MH and over	Staggered or opposite
IV	Side		Up to 2.75 x MH	One side
			2.75 x MH and over	Staggered or opposite
V	Center		Up to 2 x MH	Local roadway intersections

[a] This material is reprinted by permission of the Illumination Engineering Society from IES RP-E-1983 entitled "Standard Practice for Roadway Lighting."

Figure 10-2. Lateral Lighting Distributions.

tally and to 20 percent at 80 degrees, whereas cutoff reduces these two percentages by one half, and noncutoff places no limitations. Semicutoff is selected as a compromise between noncutoff, where high brightness in the upper part of the beam produces both discomfort and disability glare, and cutoff, where lumen control necessitates closer spacings to satisfy uniformity requirements.

c. Placement. Luminaires will be located to provide uniformity of illumination with an average-to-minimum spacing ratio not to exceed three to one, except for local residential streets where the ratio may be as high as six to one; actual requirements will be checked against the IES Lighting Handbook guidelines. Luminaires for two and three lane roads will be placed on one side of the street for reasons of economy. Adequate coverage will be provided so that security is not degraded. For four lane roads, poles may have to be placed on both sides of the road for uniformity. The illumination at intersections will be at least twice that required on the intersecting roads. Figure 10-3 indicates that to meet this requirement, two luminaires are all that are necessary for two and three lane roads; but for intersections of four lanes or those with merging traffic, four luminaires are necessary.

10-3. Area lighting Design.

a. Illuminances. Illuminances will conform to the requirements contained in the IES Lighting Handbook for average maintained illumination, except as follows:

(1) Normal vehicle parking (including minor repair). Areas will have 5 lux (0.5 footcandles) average measured on lo-foot intervals, except where higher illuminances are approved. Often, roadway rather than floodlighting luminaires may be more suitable.

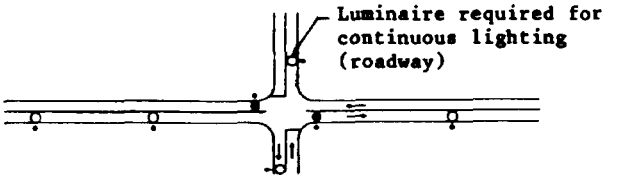
(2) *Sports lighting.* The classifications shown in table 10-2 will be used.

Table 10-2. Sports Lighting.

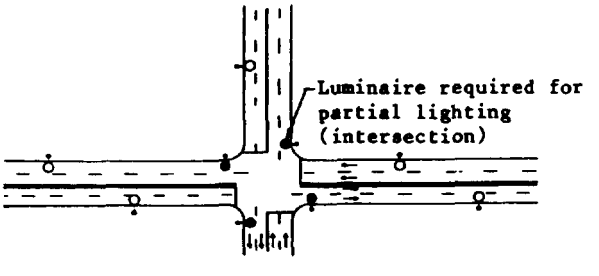
Baseball	Municipal and semi-professional
Softball	Industrial league
Football	Class III or IV
Other	Recreational

(3) *Storage areas.* Where lighting is required for nighttime use, a maximum of 20 lux (2 footcandles) will be provided, except where additional lighting has been justified or is required by the Using Agency.

(4) *Aircraft service areas.* Aircraft service areas will be illuminated in accordance with the criteria given in TM 5-811-5.



TWO LANE **ROADS**



FOUR LANE ROADS

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Figure 10-3. Intersection Lighting Placement.

b. Luminaires. Adjustable floodlights or roadway luminaires, with beam pattern selected for half over-lap, will be used as area lighting units. To provide economical coverage, a minimum of 60 percent of the beam lumens will fall within the area to be lighted. Floodlights will be enclosed type, either Heavy Duty (Class HD) or General Purpose (Class GP). A description of floodlight construction requirements is discussed in chapter 11. Use of Class 0 and Class 01 units, which are open types and accumulate more dirt, will be avoided.

c. Placement. Only areas with nighttime activities will be lighted. Floodlighting is not justified when used only for aesthetic purposes. Floodlights will be located on buildings, where practicable, or on poles or metal towers. Roadway luminaires adjacent to areas to be floodlighted may be utilized for both roadway and area lighting, where mounting height and spacing of units is appropriate for both types of illumination. Location of floodlights for apron and hardstands is covered in TM 5-811-5.

10-4. Walkway and Bikeway lighting Design.

Roadway lights and building exterior lights can serve also as walkway and bikeway lights. Maximum use will be made of multiple-purpose lighting systems.

a. Intensities. Values are dependent upon whether walkways and bikeways are adjacent to roadways or isolated from vehicular traffic.

(1) *Adjacent to roadways.* Walkways and bikeways will be illuminated to not less than one-half the maintained illumination required for adjacent roadways. Areas having changes in grade, such as stairs and ramps, will require special treatment. Crosswalks in the middle of the block will be illuminated to 1.5 to 2 times the normal roadway lighting level.

(2) *Remote from roadways.* Walkways and bike ways remote from roadways will have a minimum of 5 lux (0.5 footcandle) average illumination measured on lo-foot intervals. Pedestrian tunnels will have 40 lux (4.0 footcandles), stairways will have 6 lux (0.6 footcandles), and overpasses will have 3 lux (0.3 footcandles) illumination.

b. Pole design. Where pole-mounted lights illuminate only walkways or bikeways, shorter poles are the most suitable, but luminaire height will not be less than 10 feet. Construction will be such as to minimize vandalism by use of break-resistant lenses, tamperproof screws, and sturdy poles.

10-5. light Sources.

a. Selection. Selection of the light source will be made from high intensity discharge (HID) sources because of their luminous efficacy. The advantages and disadvantages of various lighting sources are listed in table 10-3.

b. Discussion.

(1) HPS lighting is the most energy efficient source which has an acceptable color rendition.

(2) Metal halide lamps have a good color rendition, but luminous efficacy, lumen maintenance (lumen output diminishes more rapidly throughout life), length of life, and restrike time make them a less than desirable source for many applications.

(3) *Unacceptable sources.* Fluorescent lighting has not been included in table 10-3 due to its relatively low luminous efficacy and the limited

Characteristics	Light sources			
	High-intensity discharge			Incandescent
	HPS	Metal halide	Mercury vapor	
Luminous efficacy (lumens/watt)[b]	45-135	70-110	20-60	15-25
Lumen maintenance	Good	very low	Poor	Good
Lamp life (kilohours)	10-24	5.5-20	12-24	l-3.5
lamp life (years)[c]	2.5-6	1.375-5	3-6	0.25-0.875
Startup time (minutes)	2-4	3-5	5-7	0
Restrike time (minutes)	1	10-15	3-6	0
Color rendition	Good	Good	Fair	Very Good
Neutral surface color effect	Yellow-pink	White	White	Yellow-white

[a] Courtesy of Keller & Gannon (Rev. 1991, per IES data).
[b] Ballast losses are included.
[c] Computed based on 4,000 burning hours a year.

Table 10-3. Characteristics of Light Sources.

control possible with the tubular shape. Low-pressure sodium lighting is also not included, as the color is monochromatic and therefore is not considered suitable for general use. The amount of sodium in low-pressure sodium lamps requires special disposal methods if such lamps are not to pose a fire hazard. Incandescent lighting has not been included because of the extremely low luminous efficacy and short lamp life. Mercury vapor lighting is also not included because of lower luminous efficiencies, poor lumen maintenance, higher life cycle costs, and environmental considerations (mercury propagation and disposal).

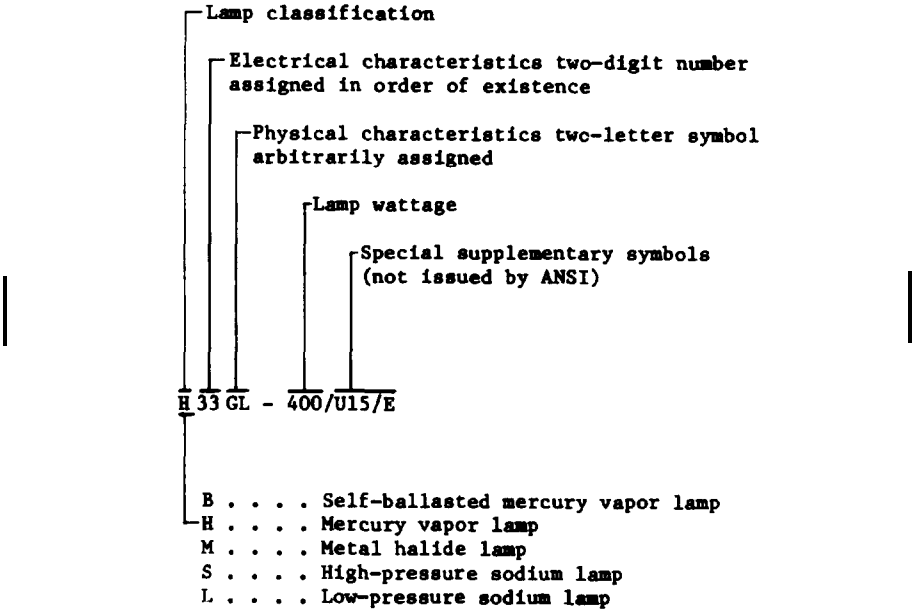
c. Lamp designations. Lamps will be designated in accordance with the requirements of ANSI C78.380 in order to provide nationally applicable and convenient lamp identification symbols. These designations ensure interchangeability of lamps bearing the same symbol. Each lamp bearing an ANSI designation has been provided with that specific designation in accordance with the method shown on figure 10-4. Although technically low-pressure sodium lamps are not HID lamps, they are included under ANSI C78.380 as a convenience.

d. Ballast characteristics. Ballast circuits and operating characteristics vary dependent upon the type of ballast circuit provided. Both ANSI C82.4 and manufacturer's terminology for ballasts can be confusing and sometimes appear contradictory. For that reason, HID ballasts will be specified by the operating characteristics desired. When ballast specifications cover indoor lamps the ANSI lamp ambient temperature range of 50 degrees F and above may he more appropriate than extending the range down to 5 degrees F, minus 22 degrees F, or minus 40 degrees F which are also available.

10-6. lighting Control and Wiring System.

a. On-off control. Luminaires for dusk to dawn operation will normally be controlled by a photoelectric cell installed on each luminaire; however, central control may be more economical for luminaires having fixed hours of operation. An automatic system using a time switch with an astronomical dial or a manual on-off control will be used for such cases.

b. Type of *system.* Multiple wiring systems will be installed, except for extensions to existing series systems or for long access roads where voltage drops exceeding that permitted for multiple lighting systems would occur. Circuits for multiple lighting will be designed to utilize the highest low-voltage level appropriate for the installation in order to keep wire sizes and voltage drops to a minimum. Lamps will be connected phase-to-neutral rather than phase-to-phase. Where practicable, units will be connected to transformers which serve other loads. Protection and disconnection of lighting circuits will be provided.



[a]This material is based on information provided in the ANSI Standard entitled "Method for the Designation of High-Intensity-Discharge Lamps" ANSI C78.380.

Figure 10-4. Key to Standard HID Lamp Designations.

c. Grounding. All lighting circuits will include an equipment grounding conductor. The equipment grounding conductor may be any conductor approved by the NEC, and will be bonded to the noncurrent-carrying metal parts of each lighting standard and luminaire.